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ABSTRACT

Using a brief series of extended interviews, a study gathered information on how corporate competitive strategies affect, and are affected by, worker training requirements. It focused on training activities involving plant-level personnel and first-level supervisors. Interviews were conducted with general manufacturing executives and training managers at 11 companies in various manufacturing fields. In all cases, international competition was a significant factor being considered in corporate planning. The study found that the companies often are restructuring in order to control costs, improve quality, and increase flexibility. From a training perspective, these three needs are motivating changes. Companies are radically redesigning the methods by which work gets accomplished, changing from supervised departments to team responsibility, with the result that more decisions that were formerly made by supervisors are now made by workers. In addition, the number of work classifications has been reduced and workers are required to be more flexible. The companies today often enroll new employees immediately in formal training programs, in addition to on-the-job instruction. Other training might include instruction in making rapid changeovers, learning multiple tasks, acquiring skills in troubleshooting, and learning to function in quality circles. Many companies also include sessions on corporate strategy, company policies, and product use. Basic skills courses are also offered for present employees as needed. (Case studies of Caterpillar, Motorola, and Hewlett-Packard are included, and a list of the companies studied is appended.) (KC)

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CORPORATE STRATEGY AND INDUSTRIAL TRAINING

Contract Report

Submitted to the Office of Technology Assessment by

Robert R. Miller
University of Houston
February 1990

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This contract report was prepared to be used as background material for the assessment on Worker Training.

The assessment entitled, "Worker Training: Competing in the New International Economy," was released in September 1990.

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CORPORATE STRATEGY AND INDUSTRIAL TRAINING

A Preliminary Report Submitted to
The Office of Technology Assessment
Congress of the United States
by
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University of Houston
Revision: February 28, 1990

Introduction

One result of escalating competition for U.S. companies has been concern that worker skills in this country might be lagging those of other nations. Such indirect measures of competence as high school literacy or mathematical skills have indicated that American students trail significantly behind those of other major industrial countries. These discouraging indicators have been accompanied by increasing complaints from business executives that basic skill levels among new hirees and some existing employees are inadequate for today's changing industrial workplace. It should not be surprising, therefore, that these concerns are reflected in rising Congressional attention to both educational practices and industrial training in this country.

The study reported here is one result of this Congressional attention. It was undertaken as part of a larger Office of Technology Assessment (OTA) project on industrial training. Using a brief series of extended interviews, the study was intended to gather information on how corporate competitive strategies affect, and are affected by, worker training requirements. The focus of company discussions, therefore, was on training activities involving plant-level personnel and first-level supervisors

or their equivalent. In addition, the research sought to reveal the extent to which training problems might be similar across a small, but diverse, set of U.S. companies.[1] In total, interviews were conducted at eleven companies, ranging in product outputs from microelectronics to heavy equipment. In each case, however, international competition was a significant factor being considered in corporate planning. Interviewees were a mix of general manufacturing or production executives and training managers; the interviews themselves were structured, but informal.

Why Training is Becoming More Important

The Impact of Global Competition: There is little ambiguity about the primary factor motivating anxiety about worker competency: international competition. In industry after industry in the United States, companies have been exposed to much increased competition from abroad. This competition typically has been based upon a combination of low production costs, functional designs and exceptional quality. For the most part, the major sources of competitive pressure are companies from Japan, both through exports to this country and, more recently, through production based in the United States. In addition, however, the American market has attracted increasing attention from effective competitors from other nations in Europe and the Far East.

The competitive phenomenon being experienced here, of

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[1] A list of corporate participants is given in an annex to this report.

course, is not limited only to the United States. Major companies throughout the world see global competitive positioning to be crucial to continued viability within their industries. It is essential in this context to be strongly competitive in all major country markets. In a sense, the process going on today internationally repeats one seen much earlier in the United States, when local or regional competitors widened their market and often their production perspectives to become truly national companies. Firms that did not meet the challenge of broadening their geographic operations often failed to develop sufficient scale to compete with larger, now national, companies. At the same time, competitive jockeying among expanding firms caused the integration of localities and regions into essentially one large market for most manufacturing industries.

Today, industrial companies are concentrating on global markets, seeing success there as the key to future profitability and, indeed, survival. This trend, which goes well beyond simply operating manufacturing or distribution subsidiaries in other parts of the world, has accelerated markedly in the past ten or fifteen years. It involves weaving operations in the major industrial nations into a globally integrated whole. For example, instead of developing products for home markets and, if successful, beginning foreign sales and production, companies now design products for global markets, introducing them simultaneously in Japan, Europe, the United States and elsewhere. International production by companies is rationalized to be mutually supportive

of global goals and objectives. We are witnessing for the first time the evolution of truly international corporations and, in the process, the development of the first globally integrated markets.

All of this movement has been made possible by the confluence of a variety of circumstances, most importantly the rapid growth in relative incomes in Europe and Japan. But, in this industrial globalization the United States takes on a special importance for companies based abroad, since it remains still the largest and most competitive single market in the world and, for the most part, is yet the home of most major industrial firms. To be a successful global player, therefore, obviously requires that firms be competitive in this country. As a consequence, companies around the world are giving emphasis to their U.S. operations, for managements know that future success globally depends inextricably on succeeding here.

Still, the major driving force in causing U.S. (and probably European) companies to rethink their competitive strategies is the assault by Japanese firms. Companies from Japan have exhibited unusual strength in a variety of dimensions but, from the viewpoint of this study, most importantly in manufacturing and production. With the opening of U.S. facilities, Japanese companies have demonstrated that the managerial techniques which led to cost leadership and consistent high quality in a domestic setting are transferable to production in the U.S. environment. In the process, American managements in almost all of the inter-

viewed companies have come to realize that their own production operations require quite radical restructuring if there is to be any hope of successful competition in the next decade.

Focusing on Manufacturing: Three needs predominate in this restructuring: manufacturing costs, quality and flexibility. Manufacturing costs have to be brought down, sometimes quite significantly, a process demanding that attention be given both to physical facilities and to capital equipment requirements. In many cases, plants simply had not been maintained at world class levels as production technologies advanced rapidly. This need, in turn, has often resulted in an international search for machinery, since much of present-day requirements no longer can be filled in the United States.[2]

It has become apparent, however, that sufficiently lower manufacturing costs depend upon a number of factors quite independent of physical facility and equipment considerations. And, again the Japanese have provided the example for others to emulate. As instances, to be discussed in more detail below, one can note just-in-time inventory schemes, special supplier relationships, redesigned workplaces, modified labor relations and careful attention to product designs that can be efficiently manufactured. All of these areas are undergoing profound changes today in U.S. corporations, in part because such changes promise to lower production costs quite significantly.

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[2] It is surprising to learn, for example, that some types of papermaking equipment no longer can be sourced in the United States.

The second major need to be satisfied, quality, is hardly a new one. Companies have always been cognizant of the necessity for delivering satisfactory quality to their customers. With foreign competition, however, has come an entirely different conception of just what the word "satisfactory" has come to mean. The automobile industry provides a ready example. American car buyers had become accustomed in past decades to lengthy "breakin" periods for engines and for locating defects to be repaired later by obliging dealers. Such expectations allowed considerable corporate laxness not only in manufacturing but also in the car design itself, a laxness that extended to major suppliers. Today, in contrast, automobile manufacturers are being driven through market demands to attempt achieving near-perfect quality in both function and appearance. International competition based on consistent quality has provided both the stimulus and the example to be replicated by manufacturers here. And, it is a pattern repeated in countless other industries.

Flexibility, the third basic need to be satisfied, also is a product of changing market demands. Traditionally, low costs could best be accomplished through long production runs involving standardized items. Achieving low costs thus depended on reducing the number and variety of products offered in a company's line. Today, on the other hand, increased competition frequently is based on offering more customization to individual industrial and retail customers, a trend which in a traditional production setting would have resulted in substantially higher production

costs and, therefore, market prices. To remain competitive, manufacturers now need to counter these tendencies by finding ways to provide the required variety while at the same time maintaining production efficiency. This search has led to the development of flexible manufacturing systems, a development that has had implications for both job design and training.

Changes Occurring in Manufacturing:

Redesigning the Workplace: From a training perspective, the three needs - low cost, high quality, flexibility - are motivating a number of derivative developments in manufacturing and production. Perhaps most importantly, companies are quite radically redesigning the basic methods by which work gets accomplished within their organizations. In case after case, ranging from electronics to heavy industry, companies are going through a frequently wrenching process of moving from individual work stations, grouped into tightly supervised departmental structures, to organizations based upon team responsibility with relatively relaxed direct supervision. This change, more than any other, promises to alter in quite fundamental ways the traditional relationships that have existed in the American workplace. Indeed, it is not an exaggeration to suggest that it will eventually lead to modifications in the entire business culture, as we have known it in this country.

To provide some flavor as to just what this workplace change implies, it is useful to recall how factories have typically been organized in the United States. Unskilled workers usually have

been assigned to single workstations, with the responsibility to carry out specific functions repetitively throughout their work shift. Parts or assemblies would move progressively from one workstation to another until the product was completed. Quality might be checked at various intervals in the process, but the maintenance of high quality was seen more as an outcome of the physical layout of the workplace than as a responsibility of individual employees. That is, maintaining quality was a matter of designing production equipment to be "idiot proof," and then, in the event of problems, correcting the machinery. Production line employees might have to possess a minimum level of physical dexterity to perform their work effectively, but exercising judgement or making decisions about production was solely the responsibility of management, personified on the factory floor by one's immediate supervisor or foreman. Particularly in unionized settings, in fact, tasks workers were allowed to do were tightly circumscribed by a plethora of work rules.

All of this is changing rapidly, at least in larger companies throughout the nation. Partly, changes are tied to technological progress, both in the types of products companies are producing and in the methods used in production itself. Fabricating products dependent upon microelectronic components, such as personal computers or automated bank teller machines, demands quite different manufacturing techniques than, say, automobile or heavy equipment production. Partly, too, changes occurring on factory floors are related to quite dramatic technical progress

being made in machinery and equipment. Newer equipment has made it possible to consider workplace designs that simply were not feasible earlier.

Probably the most important motivator of change, however, has been the competitive need to markedly improve quality, while at the same time lowering costs of production. In industry after industry, traditional U.S.-based companies have lost market share in this country to aggressive competitors from abroad. In too many cases, such losses have been due straightforwardly to insufficient attention to quality and to excessive costs, among other causes. The response to this pressure has been to adapt managerial methods and production practices to approximate those of primary international competitors, especially those of Japanese firms. It is a case once again of emulation being the sincerest form of flattery, because it is quite evident that U.S. managements have reluctantly concluded that a continuation of their own past practices in manufacturing was destined to lead to further relative decline.

Today, companies are completely revamping their past approaches to manufacturing organization. Instead of relying upon sequentially arranged individual workstations, production is more likely to be structured around worker groups. These groups frequently are given substantial authority to arrange individual work assignments, to monitor quality, to make production adjustments when needed, to schedule work through the group's production module, and even to deal directly with customers. Super-

vision in the traditional sense is often virtually non-existent, being replaced by hourly-paid group leaders whose responsibilities are defined in terms of internal coordination and liaison with other parties. In some plants, the jobs of first-level supervisors have simply disappeared or, less drastically, have widened responsibility over far greater numbers of employees. In one situation, for example, supervisors now watch over an average of 85 employees, compared with 10 before the change to a group orientation.

Implications of Workplace Changes: The net result of such modifications is that major business responsibilities that previously had been within the purview of line managers or staff engineers have now been brought directly to the worker's level. One interviewee stated, for example, that the "factory of the future" represented a rather fundamental reallocation of manufacturing esponsibilities from management to the factory floor.[3] There are numerous derivative implications. First, the change in responsibilities means that information required to make decisions, previously restricted to specific managers, must be available in a timely fashion to work groups. Thus, plants that have undergone the complete transformation to a group orientation (relatively few thus far) have concomitantly revised their information systems in rather fundamental ways. Data on new orders,

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[3] The notion variously called "factory of the future," "plant with a future" or, sometimes, "continuous improvement program" seems to be a quite common feature used to dramatize the need for change in U.S. manufacturing divisions and to organize planning related to this change.

overall factory schedules, unique customer demands, cost figures, and even sales projections are often available today on workstation computer terminals accessible by any employee.

A second implication of factory reorganization is a quite sharp reduction in number of work classifications. For teams to function effectively employees must be capable of being assigned to tasks in a flexible manner as demands change. For new plants hiring fresh workforces, organizing the factory with only a few job categories may present few problems, at least in concept. However, reducing job classifications is considerably more difficult to accomplish in a strongly unionized setting, particularly where there is a long history of union-management confrontation and mistrust. In a traditionally organized automobile plant, for example, over 100 job classifications might exist, with quite strict rules controlling how work is allocated between categories.

Today, one unionized automobile plant visited in the course of this study has been organized around only three job classifications, of which two cover maintenance workers.[4] In other cases, the trend is similar. In unionized plants, managements, often with union cooperation, have negotiated dramatic reductions in classes and, for those that remain, have altered work rules to make flexibility in assignments easier to achieve. Even in non-

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[4] Diamond-Star Motors, the plant cited here, was designed, built and is managed by its Japanese partner. Obviously, this feature of the factory makes it unusual in U.S. automobile industry terms.

unionized factories, where less rigidity typically had been the rule, flexible work assignments have become far more common than had been the case. The whole purpose of such changes is to accomplish work with increased fluidity and efficiency, at the same time drawing upon the talent and knowledgeability of workers to improve both productivity and quality levels.

A third consequence of factory reorganization, one alluded to earlier, is the changing function of first-line supervisors. Their role, where they still exist, in group-oriented plants is much less one of direct supervision of individuals and much more one of coordination and planning, functions that before were done at higher levels of the organization. Participative management calls for far different skills than many direct line supervisors possess, and frequently the adjustment has not been possible. In addition, these supervisors are now called upon to coordinate closely any necessary interchanges between group work modules and such staff departments as manufacturing engineering, design engineering, purchasing and even finance.

Finally, the restructuring of manufacturing activities has been accompanied by changes in other areas. For example, companies have been trying to incorporate just-in-time inventory programs intended to reduce stocks held to support manufacturing operations dramatically. Inventories have been a way in which managements can reduce the uncertainties related to unforeseen fluctuations in either customer demands or available supplies of parts and components. Just-in-time methods ideally call for the

delivery of such components as they are required, thereby doing away with the traditional cushion that inventories provide. While such techniques can have dramatic cost reduction consequences, they also can lead to much increased exposure to production interruptions due to possible supplier or transportation problems.

The transition to just-in-time procedures, therefore, places additional demands upon the production system. Two demands particularly are pertinent to a discussion of industrial training. First, the procedures require far more sophistication on the part of purchasing departments because they now need to evaluate potential suppliers on much more than their ability to deliver components according to a given set of design specifications. Purchasing managers have to evaluate suppliers on the basis of consistent quality, for example, since there is little in the way of an inventory cushion to absorb a shipment with numerous defects.

In addition, the relationship between supplying and purchasing companies has become closer, partly because of the just-in-time environment and partly because of the need to develop final products to satisfy rapidly changing customer demands and to do it in a manner compatible with flexible manufacturing programs. In case after case, companies are paring back on the number of vendors utilized and, with those that remain, developing day to day relationships where vendors are treated virtually as part of the firm. For example, to reduce the competitively vital amount of time between product design and customer delivery, suppliers

frequently are included in early design discussions and are expected to commit their own resources during the product development cycle. In return, purchasers promise long-term contracts for components.

The result of such considerations is that suppliers become much more integrated into the operations of their customers. The type of competitive bidding to win business that was characteristic of purchasing in a more conventional environment is less apparent today. Moreover, vendors are expected to be much more sensitive to day-to-day needs of the factory floor. High quality components delivered on time are, of course, a paramount concern, but the relationship today goes much further. For example, suggestions for design modifications might well come directly from responsible production groups. Thus, it is incumbant upon successful vendors that they have thcrough knowledge of the production needs of their customers, a need that might well dictate that supplier personnel be assigned to work with particular groups in their customer's place of business.

The move to team-centered production settings, too, is occurring because of the perceived need for much better corporate responsiveness to customer needs. Managements believe that one reason competitors, and especially Japanese competitors, have been so successful is their sensitivity to these needs and their ability to react quickly to them with necessary product modifications. In addition, there appears to be an increasing demand to customize or tailor products to individual demands. In the case

of companies who sell to other product manufacturers, the requirement here is to assist these customers in satisfying the increasingly diverse requirements of their markets or, phrased somewhat differently, to become an active partner in helping customers in their product differentiation efforts.

Summary: From a production point of view, all of this translates into a reinforcement of the need to alter significantly the manufacturing environment. Instead of past patterns of long production runs on fairly standardized items, the premium today often is on a facility's proficiency to vary production quickly between different products. Sometimes the switch might involve only a modest variation on a standard product theme; in other cases, non-trivial adjustments to the production system might be called for. And, such changeovers hopefully can be accomplished without a sacrifice of either quality levels or costs.

The requirement to shift rapidly between production modes places both technical and human demands on the manufacturing process. Production equipment must be capable of quick changeovers, while still being precise and efficient in operation. Needless to say, such demands call increasingly for computer-controlled, programmable equipment. On the human side, workplace flexibility is obviously a key element for success, and one of the primary advantages to organizing around group modules is precisely this capability. One cannot afford to waste time waiting around for a skilled craftsman to alter settings or change dies on machinery;

today, group members do it. Individuals have to be capable of moving between work stations as production requirements demand. In such an environment, teaching people to carry out a specific set of tasks to be repeated hour after hour, day after day is clearly not sufficient.

Flexible manufacturing also adds complexity to the problem of scheduling production through the factory. Although more changeovers may be required in processing today, it is still the case that fewer modifications usually result in a more efficient operation. And, where changes are required for one reason or another, minor changes typically are better than major ones. All of this translates into a difficult scheduling problem, since the seriousness or demands of a particular product change may be quite different between work sites. For this reason, it is often advantageous to allow considerable flexibility in scheduling within each module, as long as one group does not serve as a serious constraint on another or on the rest of the system. Where possible, therefore, workers and group leaders today handle much of their own scheduling within their modules.

Organizing plants around flexible manufacturing in a team-oriented setting clearly requires a substantial reorientation on the part of typical U.S. companies, one that takes time to achieve meaningfully. Caterpillar, for example, has been working to bring new methods on stream for over five years, and its management still feels the firm has a long way to go before the benefits are fully apparent. Another company, Mead Paper, initiated

changes first in a greenfield "concept" plant, and even in this somewhat idealized situation notable improvement required several years. Transferring this experience to more traditionally organized plants in the company has taken additional years, with the transition even today being far from complete.

These examples, too, serve to illustrate another point that has been very important to success in manufacturing reorganization. Both of these companies started their transformations with the full backing and support of management at the highest levels. Reorganizations require much different attitudes and skills not only at the factory floor level but also among managers throughout the company. Without the complete commitment of the chief executive officer and the authorization of appropriate training for managers, as well as workers, radical changes stand little chance of succeeding.

Partly for this reason, it is by no means clear that organizing plants around flexible groups will prove viable in an American industrial setting. Even thoughtful manufacturing executives responsible for instituting the changes in their companies harbor doubts at times. The problem is that transplantation of Japanese techniques often is made with little consideration given to other features of that country's industrial climate, features that might be essential to its success. For example, Americans have picked up on the Japanese tradition of treating employees as professionals, or at least in the United States of trying to inculcate in workers the belief that the company views them as

professionals. However, large Japanese firms often also guarantee employment, a possibly vital step that has been attempted in only a few U.S. companies. The question, therefore, is: will the cooperative, contributory climate needed for groups to function effectively survive the layoffs that would inevitably accompany economic downturns in most U.S. companies? In this study, it might be noted, manufacturing executives in the few companies that attempt to cushion employment impacts of business cycles strongly believe that such an attempt is absolutely critical to the success of factory reorganizations following Japanese practices.

Even if such external conditions were identical between countries, some observers with experience in both work environments question whether or not Japanese methods are wholly transferable to the United States. For example, one company with plants in both countries finds that the average Japanese worker possesses a better aesthetic sense and exhibits far more attention to detail than do typical American employees. These differences seem to have less to do with training and education than with fundamental cultural and ethnic features of the two societies. Thus, the company has transferred to Japan innovative product technologies, still an American comparative advantage, while at the same time depending upon the Japanese for manufac-

turing improvements to be transferred to this country.[5]

Implications for Industrial Training

Allocating more responsibility and authority to working teams in manufacturing plants could hardly be achieved without substantial attention to both hiring practices and training. Manufacturing today calls for less in the way of motor skills in many tasks, but far more cognitive ability. In addition, employees increasingly work in group-oriented cells, where performance is often measured on the basis of the group's output, not the individual's. Emphasis, therefore, is placed not only on an employee's skills, as usually defined, but also on the capacity to function constructively and to exhibit leadership and creativity within a group setting. As one interviewee put it, "Today's work environment is no place for a curmudgeon!"

Employee Recruiting: Hiring practices change to the extent that employment screening has to have additional dimensions and, in some cases, include additional steps. For example, some personnel departments have devised tests intended to measure how well individuals perform in a small group that is assigned some task. Applicants can be turned down on the basis of their presumed inability to function properly. Perhaps more importantly, in some companies the final decision on whether or not an indi-

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[5] It might be noted that such observations provide strong backing for companies to become international in their operations. Unique differences between cultural and intellectual settings often provide firms with competitive advantages that are not replicable by less internationally oriented competitors.

vidual is hired is given to the production group itself. That is, prospects are scheduled for formal interviews with the set of existing employees they might join. Needless to say, groups have a legitimate concern about new members, since their own compensation and promotion might hinge on how well such hirees perform on the job. The new hiring practices represent a recognition of this concern.

The level of other skills needed in the present workplace differs considerably between companies. In some cases, applicants are accepted for factory work only if they have completed two years in a community college program. Partly, the reason for this stipulation, new to some companies, is the increasing level of work demands, particularly in group-oriented environments. Employees must feel comfortable with tasks requiring cognitive skills that apparently go beyond those of the typical high school graduate.[6] These include the ability to understand and deal with statistical quality and process control, to read and interpret blueprints and plans, and to handle sometimes difficult scheduling problems. In brief, in some manufacturing operations, the level of employee sophistication needed simply has increased significantly.

There are indications, too, that today's average high school graduate in the unskilled labor pool is not as well prepared for factory work as in earlier generations. Students in the top half

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[6] In one company with Japanese plants, high school graduates there were fully competent to handle work that required two years of college here.

or so of their graduating classes typically opt for college enrollment, possibly in a junior college. Once there, few seem interested in pursuing a potential career in manufacturing, which has become a problem not only in finding factory workers but also for enticing much needed craftsmen and engineers into manufacturing assignments. Some manufacturing managers see this seemingly general abhorence of factory assignments as a uniquely U.S. cultural phenomenon that will adversely affect productivity improvement in the longer run. In any case, the remaining, lower half of graduates frequently lack literacy and numerical skills sufficient to enable them to perform in many factory environments, even if they desired to.

It should not be inferred from the above discussion that all companies are confronting impossible difficulties in hiring competent new employees, at least if the few companies in this survey are indicative of the larger universe of firms. In many cases the rate of expansion of company output has been achieved with little, if any, increase in overall employment. In fact, in several survey cases employment levels had actually declined in recent years. Where hiring has been done in these cases, the number of applicants typically has far exceeded needs, and companies could use their usual screening mechanisms to bring in only those who appeared fully qualified.

Why should this be so? There are a number of reasons, all tied to the increasing competitive and financial market pressures company managements are experiencing. First of all, corporate

restructuring in recent years has been quite widespread, with companies attempting to focus on core businesses in which managements feel the greatest contribution can be made by their firms. Businesses not fitting within this core grouping often have been spun off. Many companies, therefore, simply are smaller than had been the case, and the operations remaining are likely to be less labor-intensive. Probably more importantly, firms have been carefully analyzing their own production operations and in many cases have concluded that parts and components previously manufactured internally could be sourced outside more effectively. Although final product output might be increasing, sometimes rapidly, work done internally might not be.

Then too, of course, manufacturing employment overall has been directly influenced by technological change and capital investment, and the companies in this survey are hardly exceptions to this general trend. Along with extensive reorganization of factories, this general improvement in manufacturing facilities has produced higher levels of productivity. Since equipment purchases usually are made in this country to reduce costly human requirements, output quite often can be increased with little or no impact on employment.

Some caution should be exercised in generalizing from these brief conclusions. Many of the companies included in this survey were expressly chosen because they were at the forefront of manufacturing reorganization, not because they were typical of the broad range of firms in this country. Some sample companies have

had lengthy experience in dealing with new international competition and have gone through the inevitable learning process that accompanies this experience. They are, therefore, neither representative of manufacturing industry generally nor even typical of other firms in their own industries. Stories abound about companies having great difficulty in finding competent new employees, particularly among smaller firms.

One example of small company hiring problems emerged in an informal discussion conducted as an ancillary part of an interview trip covering a number of larger firms. The company covered in this discussion was a specialized manufacturer of packaging equipment and other components, employing about 120 people. The firm survives because of its ability to deliver highly innovative solutions to specific customer problems, solutions that depend upon skilled machinists internally fabricating parts and components. Because of the constantly changing technical demands being made on the company, there is a clear need for a particularly competent group of machinists, as compared with needs in larger companies of the community.

This small firm confronts a number of problems that differentiate it from bigger surrounding companies. First, despite its need for more skilled employees, it cannot afford to offer wages comparable to other, larger firms. Therefore, it is forced to hire "second best" recruits and depends upon internally generated training programs hopefully to bring these new machinists up to speed. The resources to support this training, however, are

distinctly in short supply, with the result that the number of adequately trained machinists has been insufficient to support the firm's increasing volume of business. Complicating this situation is a second problem. Health-care costs now account for about $1.50 an hour per employee, and these costs are rising by 30 or 35 percent annually. Such costs increase competitive pressures at a time when more funds could be used to support additional training for expansion.

Training New Employees: Where hiring does take place in larger companies, new employees today are likely to be immediately enrolled in formal training programs. For many companies in this survey, formal training is a relatively new step being added to on-the-job instruction that has always been quite common. These newer programs are mostly intended to accomplish two broad objectives. First efforts are directed to improving worker skills in handling some of the more recent additions to job requirements. For example, technical knowledge in such topics as statistical quality control or scheduling techniques might be introduced. In some firms, such technical training might be preceded by basic training to improve numerical or language skills, if this need has been identified in earlier screening.

The other type of training is concerned with the employee's future role as part of a work group. Sessions here might include, on a technical level, instruction in making rapid workp'ace changeovers, learning multiple tasks, acquiring skills in

basic troubleshooting, or learning to function in such group activities as quality circles. In addition, however, many companies today are including coverage of corporate strategy directions, company policies, and customer or product use familiarization. These latter sessions are intended to encourage employee awareness of the link between his or her workplace tasks and the company's overall success or failure. The expectation is that workers will be able to make positive suggestions not only on how manufacturing operations might be improved but also on how the product itself might be changed to offer customers greater functionality. The purpose is to draw employees more actively into the firm's operations both to gain better workforce morale and, hopefully, to gain the unique insights that workers might provide, in the process bettering efficiency and customer relations.

The potential impact of all such training efforts should not be minimized. To the extent that such programs can be evaluated, many companies are making careful efforts at measuring cost-benefit tradeoffs. They are finding that even training that used to be done exclusively on the work site can be greatly improved if preceded by more formal classroom or laboratory experience. That is, the time required for new employees to become fully productive can be materially shortened by introducing early training. And, training intended to acquaint new workers with the prospect of functioning in groups has resulted in positive payoffs, too. If it can be assumed that such training is a necessary precurser

to actual experience, as it probably is for American workers especially, the results of organizing around groups in terms of quality and efficiency improvement have often been quite astonishing. Some plants, for example, report productivity gains of one-third and more after their reorganizations.

Workplace training, the more traditional type of training for many companies, also has been undergoing change. Whereas earlier efforts focused on competency with particular pieces of equipment or specific tasks, today the emphasis is much more on flexibility and adaptability. Workers are expected to perform comfortably on any assignment within their group. Moreover, workplace training reinforces expectations with respect to continuing quality and product improvement. It is not at all unusual for quality circles to be assigned weekly or monthly quotas for suggestions, which can relate to the smallest incremental improvement. New employees quickly learn that their role within their groups and the company goes beyond merely performing to expectations on a specific job. Increasingly, they are being encouraged to view themselves as professsionals, responsible in their small way for the continued vitality of the company.

One can see in all of this that factory-level training for new employees is becoming more closely interwoven with support for the strategic directions of the company. Although many manufacturing executives still believe that their functions are grossly undervalued in American firms, the fact is that the need for cost and quality improvement has been recognized at the high-

est organizational levels of most firms. This need recognition has been translated into quite radical restructuring in the manufacturing sector, restructuring that has clearly necessitated much increased attention to maintaining and improving employee skills at all organizational levels. It is not at all unusual today for training executives to sit with strategic planning groups within the corporation, a status that would have been quite unusual even a few years ago.

Training Existing Employees: The metamorphosis in company training, of course, has by no means been limited to that required for incoming recruits. In fact, for many companies in this survey, relatively stable labor forces have meant that their training problem has centered more on existing workers than new employees and, it should be added, on first-line supervisors alreacy employed. Faced with rapidly changing production technologies and desiring to introduce radically modified manufacturing organizations, managements frequently have found that existing competency levels simply were inadequate. Competency here might be measured in several ways, including newly-demanded literacy and numerical skills but, equally importantly, human relations attitudes and ability.

In the usual case, determination of training needs has been part of an overall skills assessment program that many companies have initiated. Such programs are intended to enable managements to compare existing competency levels with those presumably demanded in the new work environment. Then, personnel managers can

begin to sort out just what might be remedied through training programs and what might not be. For example, it has not been unusual for companies to find that basic literacy and numerical skills have been inadequate in up to one-third of their existing workforces, a finding that typically has come as something of a revelation.

Such findings have motivated firms to initiate basic skills courses for present employees, where needed. These courses are seen as a necessary precurser to more sophisticated training at a later stage. Obviously, managements would much prefer not to spend time and money on this training, because they see it as a deficiency in the public educational system that provides them with employees, not ideally as a company problem. But, short of culling employees on the basis of present skills, which no management really wants to do, there seems little choice but to provide training internally. Interestingly, where this basic training has been offered, the reception has been mixed. In some cases, it has been greeted enthusiastically by employees, and they have done well; in other situations, however, workers have been fearful of exposing their educational deficiencies publicly, in some cases quitting their jobs rather than suffering possible embarrassment.

It is also worth noting that where companies have manufacturing operations in other industrial nations, the training needs are likely to be quite different. For example, high school graduates in Japan and West Germany seem, on average, to be about

equivalent to graduates from two-year colleges in the United States. Thus, the 300 or so hours of basic-level training that Motorola is providing for some of its Austin, Texas, workers has been unnecessary in its Japanese plant. This determination of basic skill deficiency seems quite general, and its implications are avoided only in situations where managements are in the delightful position of being able to screen employees quite selectively. Diamond-Star Motors, for example, having been able to choose only one employee from each twenty-seven applicants, now has a laborforce with an average educational level well above high school graduates.

Once some uniformity in basic skills has been achieved, training today is likely to involve some formal components and to focus on two broad categories of requirements, even with existing employees. The first might be called "technical" and is related to those foundational skills workers need to perform proficiently in today's factory. Since these workers already have experience, training concentrates on new skills that are needed in the reorganized workplace. For example, with more responsibility being brought to the lowest organizational levels, workers require the intellectual wherewithal to respond positively. Typically, that means formal training on such matters as statistical quality control, troubleshooting, handling computers, reading blueprints and plans, and scheduling. In many cases, formal classroom time is minimized in favor of training at the worksite, but this choice varies widely between companies and training milieus.

Complementing this type of training is the second generic type, that directed to familiarizing employees with working in team settings. This training would include preparation for quality circles, flexibility in assignments and group responsibilities. As noted above, supplementing this work for many companies are sessions devoted to bringing employees up-to-date on company strategic plans and policies. This training, although usually less technical, is treated with at least as much seriousness as skill-enhancing sessions. The whole purpose is to modify long-held attitudes about employee responsibility and professionality. The training helps to convince employees that their roles are vital to the continuing prosperity of their companies and that their contributions small or large are considered to be important by h..gher management. The fact is that many employees have been unab..e to make this adjustment, even though they might be fully qualified in a technical sense.

The impacts of reorganization around teams, together with focused training, have sometimes been quite startling. As just one example, Motorola's microprocessor factory in Austin, Texas, began several years ago a two-stage program of improving productivity, quality and responsiveness to customer needs. The first stage involved redesigning the factory around teams, training workers in the changeover to accept much enhanced responsibilities and greater flexibility. Little in the way of improved capital equipment, therefore, was involved in the program at this stage. Line supervisors were eliminated

entirely.

The result has been much improved performance in every dimension. Productivity has increased sufficiently that a previously crowded factory floor now easily handles substantially greater volumes of work with fewer people. Quality has improved from several hundred defects per million devices produced to perhaps twenty, and the goal now is zero defects. In addition, on-time delivery objectives are much closer to being consistently maintained. All of this has resulted in much enhanced customer relations and has reduced the pressure for expanded manufacturing facilities.

While the results of manufacturing redesign have been impressive, executives know that the program's second stage, now being begun, will be much more difficult. Changes thus far has been accomplished within the manufacturing organization through a dedicated effort to modify former ways of doing work. The next stage calls for introducing state-of-the-art manufacturing equipment and better integrating other parts of the organization into the improvement process. Today's expectation is that this stage will require a total commitment by higher management and, in addition, will demand considerably more skill on the part of factory personnel.

It should be noted, too, that the decision to make the improvement program a two-step process was intentional at Motorola. Manufacturing executives strongly believed that workplace redesign must precede the introduction of automated

equipment if the full advantages of Japanese methods are to be gained. As one manager put it, "Introducing automated machinery into a poorly functioning work environment results only in a poorly functioning automated work environment."

The Problem of Supervisors:

A Changing Role: One dilemma faced by many companies reorganizing their plants around a more open, group-oriented philosophy is the status of first-level supervisors. At a minimum, the assignments of supervisors change materially in a reorganization and, in some cases, the job may disappear entirely. In the former case, such traditional tasks as motivating and disciplining workers or monitoring and measuring employee performance might no longer be essential ingredients of the job, as these functions gravitate to employee groups. Instead, supervisors might become group leaders or assist several groups, possibly on different work shifts. Their new job is much more one of coordination and facilitating change, in some cases working more for the group than over it. Supervisors take on new roles as liaisons with other factory-concerned staff departments, such as manufacturing engineering, design engineering or human resources.

Where supervisors or foremen remain in the factory, the need is to improve human relations skills and to add to technical abilities. In a participatory management setting, the supervisory role is to assure that full participation by employee groups is facilitated and that group efforts are supported by the rest

of the organization. The stress is more on patience, cognition and teaching, less on toughness and disciplinary abilities. Inevitably, too, this assignment calls for more persuasive skills, since supervisors are unlikely to have any authority over the organizational units whose support is required, and less of the more commonly recognized skills associated with line authority. In addition, supervisors have to possess much better diagnostic skills in assessing workplace problems. And, because they have the responsibility to deal with disparate engineering units, supervisors require more intimate familiarity with technical issues associated with product design and manufacturing.

The role of supervisors in today's reconstituted factory is, therefore, entirely different from that of, say, a line foreman. It calls for a much revised set of talents and background. It should not be surprising to find under these circumstances that many supervisors who functioned perfectly acceptably in a line-management position fail to make the adjustment to a more participatory role. Some companies, anticipating that such an outcome would occur, have attempted to lessen the impact by trying to screen existing supervisors, hopefully eliminating early those who show little promise of making a successful transition. In some cases, the "untrainable" group has consisted of fully half of the previous supervisory force.

Under the best of circumstances, moreover, far fewer direct supervisors are required in a reorganized plant. The NCR example cited earlier is a case in point, and there are cases where com-

panies have eliminated the supervisor position entirely. The implication clearly is that new tasks have to be found for displaced supervisors or, alternatively, they have to be released. Almost inevitably, relocating supervisors involves additional training, an especially difficult proposition considering the likely higher seniority level of such employees.

Problems in Supervisor Relocation: Supervisors can find themselves being transferred either into group leadership positions or, more likely, into production-related jobs in a support section. Both require training. Leadership training focuses on participatory management techniques and contributions to be made as a group's (or set of groups') primary liaison person. On the other hand, training for alternative staff level jobs presents an inherent problem, since many of these jobs have themselves been undergoing quite rapid changes and, in some cases, have also been eliminated entirely. That is, functions that formerly could be characterized as quite routine have become much more demanding and now frequently call for technically-trained college graduates.

The purchasing function, already discussed briefly, presents a convenient example of this phenomenon. Making raw materials and components acquisitions for a manufacturing plant used to involve drawing up specifications, usually an engineering department's task, publicizing the plant's needs, soliciting competitive bids and choosing a supplier or set of suppliers from among the various competing bidders. The task was by no means a

simple one, since purchasing agents were expected to know intimately just where reliable suppliers might be located, to be able to monitor these suppliers, once chosen, and to assist in solving delivery and quality problems, should they arise. Even so, the job required mostly a capability to organize one's work effectively and to deal efficiently with a large number of actual and potential supplying companies.

Today, in contrast, purchasing demands far more sophisticated technical skills and, in fact, encompasses much more than the term "purchasing" connotes. Companies increasingly are forming strategic alliances with supplying firms in which competitive bidding is much less important. These suppliers are identified on the basis of their past records both in maintaining consistent quality and in providing innovative technical solutions to the purchasing firm's problems. The lengthy lists of potential bidders for components, which sometimes had numbered in the dozens, have been winnowed down to just a few. Those that remain are treated almost as divisions of the purchaser, and they are brought in at an early and still formative stage in the design of new products. Then, if the ultimate product is successful in the market, these strategic partners are assured of being suppliers of choice, as long as deliveries are acceptable in timeliness and quality.

Narrowing lists of potential suppliers directly increases efficiency in purchasing, of course, but the new strategic alliances are also intended to achieve a number of other, more impor-

tant goals. Managements hope, for instance, to reduce the time typically involved in product development cycles. By involving suppliers in the design phases of projects, companies expect to pare the number of steps in the sequence from design to market and, by so doing, reduce the time and expense in introducing new products. In addition, the careful selection of strategic partners anticipates that these sister companies can supplement the innovative and technical skills of the purchasing firm at a time in the design-manufacturing sequence when product alterations are simpler to achieve. Finally, aligning partners closer to the company's goals and objectives gives some assurance that every effort will be made to conform to delivery and quality demands, both of which are becoming much more stringent in today's manufacturing environment.

Needless to say, consolidating supplier lists can have severe adverse impacts on those vendors least able to adapt to the new competitive environment. Purchasing companies may work closely with those suppliers finally identified, but the process of narrowing numbers of suppliers is more a matter of the fittest surviving, a process where buyers tell supplying firms that past levels of performance must be improved but offer little in the way of guidance. One might expect that the winnowing process would favor larger suppliers, with the technical and financial capabilities to adapt quickly, over smaller competitors with more limited resources.

In any event, the result of such changes is that older

purchasing functions have been turned inside out. The need now is for seasoned executives with mature technical experience and judgement who are, in addition, capable of working closely with partner supplier organization. The major task today is one of intimate technical liaison, not arm's length dealings with numerous potential suppliers. Priorities shift, therefore, more to technical and managerial talents, less to sorting among vendor listings and evaluating competitive bids. But, insofar as relocating former production supervisors is concerned, the purchasing option does not present an encouraging possibility.

The unfortunate plight of some first-line supervisors in a changing manufacturing environment can be generalized. Because much of the motivation for lower costs and higher quality comes from Far Eastern competition, efforts to improve production efficiencies have obviously concentrated on lowering labor costs. And, as noted above, reducing labor costs has been achieved both through better production technologies and through workplace reorganizations. In the simplest terms, for a given output level the goal has been to pare back the number of production workers required or, equivalently, to increase output without increasing the number of workers. For many plants, and especially for those in this survey, progress toward this goal has been quite dramatic.

Productivity gains, however, have not been achieved without some tradeoffs. As the need for line production workers has declined, more supporting personnel may be required. An automated

factory, for example, demands more maintenance people than one less automated, even though production worker numbers might decline. Usually, of course, the substitution of staff for production employees is much less than one-to-one, and the end result hopefully is lower overall unit costs. Still, the added employees are likely to be at higher skill levels than those released from production jobs. Old-line supervisors, many of whom were promoted from the production line, frequently have not had the requisite education to fill some of these new support functions. Thus, finding alternative slots for now redundant supervisors has often not been a simple task.

Changes Occurring in the Training Function: The increase in training requirements at both worker and supervisor levels has caused a commensurate increase in the attention being given to the training function itself. Already mentioned, for example, has been the up-grading of training within corporate strategic planning units. It is also true, however, that many companies have not had a particularly firm grasp on their costs of training and, perhaps more importantly, on the effectiveness of such actitivities. When training has been done mostly one-on-one in the workplace, as it has in many firms, costs can be buried as part of essential manufacturing outlays, and effectiveness can be measured simply by whether or not new employees learn how to operate equipment. As programs have become more formalized and as more and more employees are placed in training sessions, managements have become more cognizant of training as an explicit

cost center. Even in companies where training departments have existed for some time, far more attention is being directed to containing costs today than had been the case.[7]

Efforts to control costs have run in three primary directions. First, virtually all companies in this survey either track employee training closely already or are establishing systems to accomplish that task. These systems, usually computerized and available to both employees and supervisors, record the training needed (and accomplished) according to specific job requirements or, in some cases, to the needs of likely future jobs. Typically, employees are allowed to enroll only for those courses deemed necessary for job performance. That is, training is more and more being linked specifically to individual job-related requirements. Gone in many companies are the days when employees could choose from an extensive menu those courses or programs that appeared to be interesting or valuable on some personal dimension.[8] Today, companies are demanding that the training be directly pertinent to task performance, either now or in the immediate future.

A second direction taken in controlling training costs is tighter measurements of results. This matter was discussed

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[7] One could bring the IBM case from one of the other contractor reports in here. There the company was quite shocked to learn how much money was being spent on training and education, and the finding caused cost reduction efforts to be launched immediately.

[8] Larger companies might have several thousand offerings available in their training catalogues, if all levels of the organization are taken into account.

briefly earlier and centers on an attempt to find out in quantitative, measurable terms just what the training has, in fact, achieved. At its simplest level, this measurement might only be pre- and post-training testing, virtually standard in industry today. This measurement would be equivalent to a school examination, where presumably the amount of additional knowledge learned in the training is assessed. The other end of the measurement scale, ascertaining improvements in actual job performance as a result of training, obviously is far more difficult and, for most companies, is only beginning.

The problem in measuring "bottom line" improvement from training is that most training is not conducted in an isolated or abstract environment. When training takes place, it is often done in conjunction with other changes being made. For example, classes might be conducted simultaneously with alterations in workplace design or in equipment usage. When anticipated improvements in productivity take place under these circumstances, it is not a simple matter to ascertain just which component of change was responsible for specific increments of better performance. The fact is that the components were probably interdependent and, where that's true, measurement of any single dimension is impossible. Still, companies increasingly are trying to find tolerable measurement schemes in order to get a better handle on whether or not costs of training ultimately contribute to profitability.

A third way costs are being contained is through innovative

new approaches to the educational process itself. Efforts here might be as straightforward as analyzing in a cost-benefit framework just how training is to be provided. For example, several companies in this survey have reduced the size of their own resident training groups in favor of using private contractors, a choice that gives much more flexibility in offerings as well as providing an opportunity to draw upon a wider range of expertise. In addition, however, companies increasingly are experimenting with technology-based training delivery systems keyed specifically to higher productivity. For example, self-paced and computer-based training modules are being used widely and, in some cases, are produced within the corporate training department itself. So also are interactive, video disc instructional media becoming more common and they, too, might be produced on-site.[9] For several larger companies, moreover, facilities for remote reception (and transmission) of training courses are routinely available via satellite.

All of these efforts to control costs are quite impressive from an educator's point of view. They represent recognition that for corporate strategic plans to be carried out, extensive new training will be required, but the training, as with all activities within competitive firms, must be done within strict cost boundaries. The result is that companies are engaging in far more aggressive experimentation with new methods of trans-

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[9] As one example, NCR expects to save $70 million in annual training costs through use of technology-based, internally produced training methods.

mitting knowledge than are more traditional educational institutions at any level. They are, in addition, much more active in finding ways to control training costs effectively and in measuring results. Thus, one might speculate that private corporations, taking a clear lead in both innovation and measurement, could provide a much needed example for reforming educational processes more widely throughout the United States.

Summary and Conclusions

The Link Between Strategy and Training: It is obvious, therefore, that industrial training has become one of the primary means by which companies in the United States are attempting to implement broader strategic plans, particularly in manufacturing. These plans quite clearly are being driven by the dire need to meet cost and quality competition both from firms based abroad and, increasingly, from other domestic companies. They are, moreover, often expedited by following the examples of these successful competitors, especially the Japanese, who have demonstrated that their own manufacturing prowess is transferable knowledge and, hopefully, adaptable to an American business environment by American managers. At least in the larger companies represented by this survey, executives increasingly see continuous training as an investment as necessary for competitive survival as that for plant and equipment.

It is equally clear that these companies do not see worker competency as an insurmountable problem standing in the way of

achieving corporate goals. Even in situations where firms are finding fundamental basic skills lacking, it is viewed as a problem to be overcome prior to more specific forms of training, not as a strategy-modifying roadblock. To be sure, managements would prefer that achievement levels were much better among the typical high school graduates that often make up their entry level manufacturing employees. Concern is so deep, in fact, that companies are taking a much more active role in community efforts aimed at improving public schools and junior colleges.

But, because manufacturing companies usually offer wages considerably higher than the community norm, many thus far have been able to draw from a relatively select group of applicants for most of their needs. Where additional skill has been needed by expanded job requirements, many firms simply have increased permissible entry qualifications, narrowed the applicant pool somewhat and hired workers with some post-high school education. In addition, with rising productivity and restructuring, companies often have had only modest entry level staffing requirements, again causing them to be less concerned about competency than might otherwise have been the case.

Minority Problems: There are exceptions to these generalizations that continue to motivate some concern. Most importantly, companies are not free to hire just anyone who meets their particular screening requirements; they are faced in addition with satisfying equal opportunity guidelines. And, when entry level minorities are recruited, it is an unfortunate

reality that numerical ability and language skills, especially, might be below acceptable standards. For such cases, companies have established special basic skills training, sometimes done through cooperating public agencies, sometimes internally within the firm's normal training activities. Again, it is a barrier not seen as insurmountable or slowing corporate plans, but obviously it is also not a situation that managements would prefer.

Problems with Suppliers: The other exception that causes concern is the entry-level employee training problem being faced by suppliers. Executives of larger companies fully understand, first, that appropriate training of new employees by suppliers is vital to their own interests and, second, that suppliers are not in an equivalent position with respect to either training or recruiting. Typical suppliers are smaller, pressured by costs and often relatively unsophisticated. Yet, their performance is obviously highly important in a quality-conscious competitive environment, particularly one devoted to just-in-time deliveries. The fact is that suppliers often are not able to recruit new employees at wage and fringe benefit levels as high as larger companies, with the consequence that the average competency of hirees is likely to be considerably lower.

Partly for this reason, major companies often are opening their own training facilities to their suppliers and are assisting them in other ways to upgrade employee competency. Executives in the larger companies see the development of proficient

suppliers as the foundation upon which the whole industrial structure relies, and a foundation that today is perilously weak. Training assistance is intended as a barely adequate means to overcome these supplier deficiencies as well as to increase familiarity with the vendee's production requirements. Many managers believe the inability of smaller suppliers to undertake meaningful training is a matter of grave concern to the competitive hopes of the nation.

Existing Workers the Major Problem: For larger companies in this survey, the primary training problems relate to existing employees, not new ones. These problems are caused primarily by new technologies being employed in the workplace and by quite drastic alterations being made in the work environment itself. New technologies incorporated in machinery and equipment can have quite diverse impacts on work performed. One might expect that higher levels of technology would demand commensurate increases in worker skills and, without question, such a result frequently occurs. High productivity machinery placed in an environment where consistent high quality is required might involve much closer attention and a capacity to understand how to quickly modify equipment settings.

Such a result, however, is by no means universal; often, so-called high technology equipment reduces skill requirements. An example from Diamond-Star Motors illustrates the point. This joint-venture plant incorporates almost five hundred robots, making it perhaps the most automated automobile factory in the

world. Among the many tasks accomplished today using robots is windshield placement. This job formerly involved careful application of a butyl sealing compound around the windshield opening, a task followed by placement of the glass itself, both jobs requiring some measure of skill and experience. All of this sequence today is automatic.

It is true, of course, that Diamond-Star is, on the whole, a more skill-intensive environment than a typical automobile plant. The maintenance of enormous numbers of robots certainly increases the demand for more skilled employees, even as the equipment is eliminating some semi-skilled tasks. The point here is that production line workers do not necessarily require more skill in an automated setting than would be true in an earlier time.

Probably the more important development in terms of industrial training is the increasing popularity of structuring work within teams. This organizational restructuring within manufacturing, as we have seen, affects the need for training (and retraining) quite directly, because workers are being asked to contribute much more than had been the case. Training in quality control, technical adaptability, flexible performance, scheduling, group dynamics and even customer relations all flow from the shift from individual work arrangements a to team-based environment.

Other Changes Stemming From Reorganization: There are, in addition, a number of ancillary changes brought on by the need to implement a group orientation factory plan, and some of these

changes also can involve training in other parts of the organization. For example, performance evaluation techniques are modified quite extensively with teams, because measurements need to be tied to group, rather than individual, performance. This requirement forces personnel people to think in quite different terms than had been true. Should performance measurements be related solely to the group output and quality, or should a wider evaluation be used? If the smaller group is used, will behavior be encouraged that sets off one team against another, to the detriment of the whole operation? Such questions are not ones asked historically, and approaching answers can require training in order to alter long established habits and, indeed, biases. The same type of difficulty comes up in considering compensation schemes.

In addition, team organization places additional demands upon engineering and other support groups. Quite frequently, engineering personnel are assigned to work with individual factory teams, actually spending a large proportion of their time on the plant floor. These engineers need to be responsive to suggestions and ideas of individual workers, as well as to assist in such group functions as quality circles and product improvement sessions. It probably goes without saying that such an intimate level of cooperation is not something that experienced engineers and others are accustomed to, and the transition usually requires outside help in the form of training to develop the required new skills.

Still, the whole purpose of organizing around teams and participative management is the improvement of operations. As one interviewee put it, "We are only now realizing that the enormous reservoir of talent represented by our employees can be tapped through appropriate organizational and managerial methods, but so far we've only scraped the surface." The validity of the remark is seen in the fact that for many companies the results already have been quite astonishing: much greater productivity, far superior quality levels, and significantly better employee morale. For some firms, the adjustment required only a modest transformation of earlier employment policies. For others, however, revising organizational practices has required years of experimentation in pilot operations before significant results were forthcoming, and, once learned, transferring that experience to older plants has often been surprisingly difficult, especially where lengthy histories of labor-management confrontation have been in evidence.

Some Conclusions: It should be noted that even manufacturing executives who have successfully engineered the transition for their companies are not at all certain that the participative techniques used by Japanese companies are permanently transferable to the United States. Many are quite cognizant of the fact that a seven year business expansion thus far has provided unusually fertile ground for experimentation but that the real test will come in the inevitable cyclical downturn. Lasting success of team-oriented programs depends inextricably on

employee beliefs that they are part of a professional team trying to improve value for the firm's customers. Obviously, such a belief can hardly be fostered in an environment where economic duress is answered almost immediately by extensive layoffs of manufacturing employees.

Some of the companies in this brief survey have long had employment policies providing assurances to workers that any difficulties coming from business declines would be shared among all employees, workers and managers alike. For these companies, the transition to new technologies and group organizations would appear to be quite feasible. Even here, however, the need to stabilize employment in downturns has motivated managements to employ more and more temporary workers, in some cases now amounting to thirty or more percent of the workforce. Integrating these temporaries into a professionally-oriented team setting obviously is not a simple task, and the reality thus far is that no one has quite figured out how to do it.

For many other companies, factory employees have been treated more or less as a variable cost. When recessions occurred, employment of these workers could be temporarily terminated for as long as the need lasted, even if it meant closing entire manufacturing facilities for months. Few among the manufacturing and training executives interviewed here believe that the distinctive benefits that might come from participative approaches to factory management could withstand such periods of severe layoffs, particularly if factory workers are

treated differently than others in the organization. As a consequence, more lasting success in these new management practices, in the opinion of many manufacturing executives, depends upon a quite dramatic shift in traditional business practices in this country. Whether such a change will take place clearly remains to be seen.

Such considerations, it should be noted, go to the heart of American business practices, as contrasted with Japanese, in ways that might not be fully apparent. For example, the need to maintain employment in larger Japanese companies is a matter not only of so-called "permanent employment" practices but also one rooted in managerial beliefs. That is, Japanese executives feel responsible for employees in ways that are not usually found in American companies. Because of such beliefs, Japanese companies go to great lengths to maintain output, as long as the resulting revenues cover their incremental, not average, costs of production. As American companies have learned in many industries, Japanese firms frequently price goods at levels well below their full costs of production both at home and in overseas markets in the hope that production volume can be sustained.

This practice, which flows directly from the perceived demand to maintain employment (and, therefore, production), is at marked variance with usual business practices in this country. Here direct labor costs are treated as variable, which means that the incremental costs to be covered in this country are considerably higher than in Japan. American managements are much

more willing to maintain prices, even if production is cut, than would be true for Japanese firms. The point for this study is that if the adoption of Japanese manufacturing practices in the United States persuades managements here to stabilize employment, as is probably necessary for the full effects of such practices to be experienced, then that change is bound to have derivative impacts on traditional pricing and marketing customs in this country.

This problem also is pertinent to industrial training, since it, too, has often been treated as a variable cost in this country. When business is poor, training can be cut with little permanent harm to the enterprise, the belief goes. Interestingly, some companies are experimenting with concentrating some types of training into periods of slack demand, hoping to use such times for upgrading employee skills for their return to their workplaces. In most cases, all of this training would be accomplished on company time, usually with full pay during the down period. These efforts have met with mixed success, but more importantly they are clearly the exception to the rule. Most firms still subscribe to start-stop practices in training that are neither consistent with the Japanese practices being emulated nor likely to lead to success in an American context.

One can conclude, therefore, that the successful transplantation of Japanese manufacturing techniques to this country will depend also on a variety of changes in U.S. corporate practices, some of which will be quite profound. A few

of these have been suggested above, but there are many others. For example, the thinning of managerial ranks through reducing organizational layers already has been seen to alter quite radically potential career paths for professional employees. Fewer managers obviously means fewer promotional possibilities for employees, with the result that traditional views toward career success will need to be altered. Success cannot be defined only as "climbing the corporate ladder," since far fewer opportunities will exist there.[10]

One way that can be accomplished is by transferring additional responsibilities, formerly within the purview of "middle" managers, to lower levels with commensurate increases in compensation. Such a change clearly would mean that compensation and measurement methods of the past would become much less appropriate to tomorrow's work setting, not only in manufacturing but throughout companies. More importantly, a flattening of organizational structures inevitably will have a similar effect on compensation differentials between remaining organizational levels, a phenomenon readily observable in Japanese corporations today. The ratio of top executive compensation to worker pay is much lower in Japan than in the United States, a fact probably

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[10] It might be noted that General Electric Company has experimented with dual routes to success ("individual contributor" and "manager") for over thirty years, with mixed results. The major problem, one relevant to this section, is that individuals have to be made to feel that equivalent financial success is possible through either route. In the past in American companies, it is apparent that managerial skills have been considered to be in shorter supply than functional skills, at least if salary differentials can be used as a reliable guide.

due more to organizational than to cultural differences between the two countries.

One essential ingredient to the successful transplantation of Japanese manufacturing techniques, one noted briefly earlier, is top management understanding and commitment. The first of these, understanding, involves a thorough grounding in precisely what these practices can achieve, why they seem to work and, last but not least, what conditions are required to gain the benefits. Although this understanding appears to be gaining ground, it should be said that it by no means exists throughout the U.S. industrial establishment. In some cases, management support of team-oriented approaches appears to be motivated more from a casual observation that they seem to work in other companies, less from a comprehension of the reasoning underlying them and their implications for operations.

Executive commitment is equally important, for without it radical change inevitably will fail. The effective move to new manufacturing technologies and revised work arrangements demands an unusual level of cooperation throughout a company and time for training to begin to alter long-existing corporate cultures. Without firm direction from the top, organizational inertia and old behavioral patterns surely will dominate. As a matter of record, in this survey at least, those companies in which training was being used to lead a complete modification in corporate practices were all guided by managers who exhibited a strong belief in the real need for change.

CATERPILLAR, INCORPORATED

Practically everyone can quickly identify Caterpillar (Cat) as the world's preeminent producer of earthmoving equipment. The company's familiar yellow machinery is as recognizable in the remotest parts of the world as it is in the United States. Historically, Cat has sold more than half of all equipment found globally, and the firm has enjoyed an international reputation for high quality and customer service. In addition, because of its preeminence in equipment sales, the company has staked a strong position in the substantial market for highly profitable parts and maintenance components.

Such a seemingly unassailable position, however, was threatened in the early 1980s by a quite unique combination of events. Perhaps most important was the decision by Japan's Komatsu to become a viable international competitor of Cat's. This company expanded its product offerings, where its earlier strength had been in smaller equipment, to a full line of earthmoving machinery. Moreover, Komatsu moved aggressively into Far Eastern markets and, indeed, began to line up dealers in the United States. This was a major problem in the Komatsu strategy, since Cat had long been able to take advantage of the strongest set of dealers in the world.

And, there were other problems. First, the exchange rate moved against Cat, with the dollar gaining some 40 or 50 percent against other major currencies. With much of Cat's production concentrated in U.S. plants, the company quickly was placed in a severe price-cost squeeze. In addition, the traditional domination of international construction markets by U.S.-based companies was eroded rapidly by competitors in such countries as South Korea and the Philippines. These newer companies did not share the loyalty of U.S.

contractors for Cat equipment.

The net outcome of such events for Cat was a substantial deterioration of its income statement. Over three years during the mid-1980s, the company lost over a billion dollars. Although the situation has eased somewhat with the return of the dollar to lower levels, the traumatic business experience of this period has significantly altered Cat's way of doing business, particularly in manufacturing. The emphasis today is on two aspects: reducing foreign exchange exposure and bringing down overall costs of production. The first objective involves sourcing more components abroad and generally adding more product value in foreign plants; the second, of more interest here, entails a careful analysis of manufacturing costs and a significant revision of the company's production operations.

Costs have been addressed in two primary ways, both having implications for industrial training within the company. First, and perhaps most importantly, is a reallocation of production from internal sources to outside vendors. Unlike in past times, when Cat managers took pride in the fact that most parts and components were manufactured internally, much more is sourced outside. The purpose is to reduce costs, including inventory costs, and to improve manufacturing flexibility. Today, the company has to have a comparative advantage in technical skills or a desire to preserve core technological competence for a component still to be produced inside. Although its billings are higher, the company now has forty percent fewer employees than it did ten years ago.

The other way costs have been addressed has been through a radical restructuring of manufacturing operations. One facet of this program has been a reduction of work-in-process through a move toward just-in-time inventory

policies. Although much remains to be accomplished on this program, substantial reductions in in-plant inventories have been possible. Another part of the program involves a complete redesign of workflows through the manufacturing. As in so many other companies throughout the United States, Cat is moving toward organizing work around production cells, where teams of workers have responsibility for their quality, productivity improvement and on-time delivery. These cells also are being provided with state-of-the-art flexible manufacturing systems.

An example of such changes is Cat's transmission plant located in Peoria. This factory, which makes all company transmissions, is for the most part being organized around machining cells. The plant includes provision of a "use point manager," where assemblers at single workstations would be responsible for putting together a variety of different kinds of transmissions. Assembly kits with all needed parts would be waiting for the assembler at the beginning of the work shift, with subsequent assemblies delivered on a just-in-time basis. The hope, and expectation, is that cycle time can be reduced from three months to just a few days, with commensurate reductions in work-in-process.

Although most training funds in Cat are still spent on technical and supervisory personnel, this seems to be changing. All factory workers today are included in the firm's skills management system (SMS), where skills and traits required on the job can be matched with particular employee competencies. Subsequent training to deal with deficiencies might involve classroom work, as in the company's technology familiarization program, or structured on-the-job training. Also, training is directed to helping workers cope with group-oriented production settings in which far less formal

structure, in terms of job categories, exists.

As with many other major manufacturers, Cat is in the process of paring back on numbers of suppliers. For those that remain, the company expects not to have to check in-coming quality levels, and each vendor will be certified annually. Because suppliers are not having an easy time with the much increased quality levels now expected, Cat has found it necessary to provide assistance through training, at cost, of supplier employees and of vendor trainers. Typical of the types of courses involved are statistical quality control, quality and productivity improvement, bluepring reading, and geometric dimensioning and tolerancing.

Finally, the company is concerned about the diminishing number of machinists and other skilled workers that are becoming available. Future needs for such skills will far outstrip what today appears to be the future supply. To partially ameliorate this situation, Cat revived its apprenticeship program after having cancelled it during the company's recent difficult times. As in other companies, however, finding acceptable candidates to join an apprenticeship program is an increasingly difficult task, with the result that Cat expects shortages of skilled workers within the next decade.

Cat's training, therefore, is being driven by changes occurring in factory organization. Less supervision, flatter organizational structures, a just-in-time environment, more production flexibility, higher quality demands and lower costs all are elements placing greater demands upon worker competencies. As in many other manufacturing companies in this country, Cat's program in its basics emulates Japanese practices and results in substantially more responsibility being placed on individual factory workers and teams. How successful such practices will be in the long-run in a Caterpillar-like environ-

ment, where a history of labor discord has been in evidence, remains to be seen. But, it is abundantly clear that Cat's management has decided that past practices would not be sufficient in the global competitive setting of the future.

MOTOROLA, INCORPORATED

Motorola is a corporation that prides itself on having aggressively taken on Japanese competition, both at home and in Japan. Its mobile communications products, especially, have become international leaders in functionality, quality and low cost. In addition, Motorola has become the leading U.S. supplier of semiconductors, competing with Intel in innovative microprocessors and recently re-entering the market for dynamic random access memory chips, a product earlier abandoned in the face of Japanese competition. The company's management also has led industry efforts to gain better access to Japanese markets, actively influencing the American government to adopt a stronger stand on the issue. This pressure has been credited with substantially improving Motorola's Japanese opportunities in cellular communications devices and semiconductors.

The company also has become a model for developing creative new approaches in its manufacturing activities and, related to them, for its dedication to industrial training. An example of the results of this combination are reported here in a brief review of recent changes in Motorola's microprocessor manufacturing operations in Austin, Texas. This facility embarked upon a two-stage program to improve quality, customer relations and costs. The first stage, recently completed, entailed a complete redesign of manufacturing operations, with relatively few capital expenditures; the second stage will involve more emphasis on the acquisition and placement of new flexible manufacturing equipment.

It should be noted that direct labor in the production of microprocessors does not represent a major cost element today. Labor costs for typical devices account for only about five or six percent of the total. From a

competitive point of view, therefore, improving labor productivity alone is less important in this product than might be the case in other types of manufactured goods. It is also competitively less vital than a number of other considerations in microprocessors themselves.

Still, paying attention to factory organization can yield benefits in addition to improved productivity, as Motorola found out in its Austin changeover. The expectation, ultimately fulfilled, was that better efficiency would be accompanied by improvements in quality, delivery times, production flexibility and employee morale, all in addition to productivity gains. Each of these areas was critically important in the company's efforts to compete effectively with suppliers in the United States and abroad.

The major element in the organizational redesign was a move from standard production arrangements to manufacturing established around work teams. These work modules encompass varying numbers of employees, ranging from as few as six to perhaps twenty, and are organized around particular tasks to be performed flexibly on a variety of products. Since the plant operates around the clock, 24 hours daily, the equipment within a module might be shared by as many as four worker groups. In the words of one executive, "The strategy was to make the product mix problem more manageable from the factory floor, to inculcate a strong sense of ownership and accountability in which participative management principles could be applied as intended, and to create an operating environment in which manufacturing could focus exclusively on execution, by relieving it of the need to address more mundane, but very time-consuming, housekeeping issues."

Direct supervision in Motorola's plant has been eliminated entirely. Instead, group leaders, who are hourly employees, are assigned within each

unit. Their responsibilities, however, are much different than those of the displaced supervisors. Group leaders function most as planners, taking into account future demands coming from incoming orders, and as liaisons with manufacturing support groups. Teams are accountable for output quality, on-time delivery and productivity improvement. In addition, because of the capital intensive nature of the production process, each group has assigned to it a technician and a manufacturing engineer.

The results of this redefinition of manufacturing have been impressive. A plant floor that had been reaching capacity with some 1.5 million devices now produces more than 4 million monthly, with room to spare. The direct workforce has been reduced by half, but on-time delivery has been much improved. Quality, which used to be measured in hundreds of defects, now is down to perhaps fifteen or twenty, and the number is declining toward the firm's "six sigma" goal of essentially zero defects. Such results are striking when considered in the context of the program's first phase, which was not intended to involve much capital investment.

The original planning format set forth by Motorola manufacturing executives seems to be well supported by this evidence. The idea was that it makes little sense to attempt automating a poorly functioning factory; the result of such an attempt can only be a poorly functioning automated plant. It is important first to create the setting for further improvements to take place, and that is done through a radical restructuring of the manufacturing operation itself along the lines of participative management techniques. These techniques, which probably originated in the United States, are best exemplified by Japanese management practices in manufacturing, and the Motorola redesign is a conscious attempt to emulate those practices in this country.

From a industrial training perspective, the Motorola experience also provides some guidance. Teams are much more demanding in terms of cognitive skills than are more traditional production environments. Workers are expected to deal with statistical process control concepts, difficult scheduling problems, product enhancement efforts, production improvements, even sometimes with customer relations. Completely redesigned information systems bring business data directly to the factory floor, and team members are expected to know how to interpret such data for their own group and to decide upon appropriate actions to be taken. Such demands, in turn, imply more in the way of numerical and verbal skills than was necessary earlier.

The fact is that when a skills assessment was conducted in Motorola's plant, nearly one-third of the existing workforce was found to lack necessary language and numerical skills to function effectively in the new manufacturing setting. Two points can be made. First, the deficiencies were not apparent in the older work environment, which is a discovery that has not been unique to Motorola. Second, the level of basic skills in Motorola's Japanese plants do not reveal similar functional problems. In brief, it is a case of a comparatively inadequate public educational system in the United States graduating students with insufficient skills to function in today's more demanding workplace.

Motorola has met this need by beginning a basic skills course for these existing employees. The course will require about 300 hours for each worker involved. Although Motorola has not been hiring many new workers recently, with downsizing more the rule, the site is currently undergoing a major manufacturing expansion that will require additional employees. Few in the organization would anticipate that the skill levels of prospective recruits

would be much better than those of the existing workforce. Thus, although the company would obviously much prefer not to invest in remedial training, it is probably faced with that prospect for some time to come.

It is also true that the second phase of the manufacturing improvement program, where sophisticated flexible equipment will be acquired, will place even more stringent intellectual demands on workers. Current training in team approaches to work, quality control and the like will need to be supplemented by specific training on the newer pieces of equipment. On this, Motorola is developing much closer strategic relationships with machinery suppliers. These relationships are intended both to give vendors a early view of Motorola requirements and to furnish information on future training needs.

In pondering the dimensions of its "Plant of the Future," Motorola managers believe that the days of long production runs on standardized devices are pretty much over. Instead, the trend is much more toward customization of chips for individual customers, implying that future plants will need to be highly responsive to shifting market demands and shorter production runs, all within a context of low cost and high quality. The demand, therefore, is more and more for manufacturing flexibility, both in capital equipment and workforces, a move that will inevitably result in difficult-to-attain requirements for manufacturing planners.

Thus, impressive though they may be, the improvements realized so far have to be seen as only a beginning on a difficult adjustment to the competitive realities of the coming decade. In fact, further improvements of the future may well be more difficult to bring about than the recent changes. The reason is clear. Adjustments thus far could be made within the manufacturing sector alone, although without question even internal changes involved over-

coming substantial bureaucratic inertia. Future improvements, in contrast, will be possible only with the active cooperation of a number of other business groups - design engineering, finance, personnel, for example. Without full commitment from executives at the highest levels of the organization, such cooperation may not be easy to obtain.

HEWLETT-PACKARD CORPORATION

Hewlett-Packard (H-P) is a company that in its forty year history has grown from a small entrepreneurial start-up to become a multinational corporation with over $10 billion in annual sales. The company manufactures and sells a set of electronics-based products ranging from aviation instrumentation to scientific calculators, personal computers, peripherals, minicomputers and workstations. H-P also has a long history of "enlightened" personnel policies, where training to enhance employee skills at all levels is well established. Even so, H-P is reconsidering its traditional methods of managing its farflung operations, a process motivated by changed competitive conditions and the need to lower manufacturing costs and improve quality. The organizational umbrella under which this reconsideration is occurring is called the "Factory of the Future" program.

Until recently, H-P relied upon an organization designed around individual product divisions, each of which was highly autonomous in its operations and, of course, responsible for its own profit performance. The idea was that innovative businesses, where technical change took place rapidly, were best managed for growth by executives free to essentially run their own shows. Although personnel and other broad policies were set forth by H-P's headquarters, individual divisional managements had considerable latitude in their interpretation and implementation of these policies. From the beginning, the company has tried to stabilize employment; when the inevitable economic downturns occurred, managers and workers alike might take a week or two off.

Today, H-P is attempting to develop a more integrated structure in which some functions are becoming more centralized. The reason has both technical and competitive components. On the technical side, the company is finding

that its various product lines more and more are being viewed by customers not as individual products but rather as sets of product offerings providing overall solutions to the customer's technical problems. Obviously, the company is being forced to think in similar terms. In addition, production processing is changing in ways that make thinking about integrated solutions more necessary. Competitively, the firm, always a quality-oriented seller, is finding that its costs of attaining this quality are comparatively too high and must be brought down.

Operating divisions are being linked together as strategic business units and manufacturing reorganized. As in many other cases, the reorganization focuses on a team orientation, where workers are being trained to take responsibility for production, scheduling, quality and costs within their work module. In addition, workers are expected to come up with the means to improve both efficiency and product functionality, both areas that earlier had been the primary responsibility of staff groups.

These changes are more complicated than might be apparent. For example, the management information system needs to be completely redesigned in a way that will bring pertinent information to the factory floor on a continuous basis. Measurement and compensation schemes need to be completely redesigned, concentrating on team, not individual, performance. And, probably most importantly, both worker and managerial attitudes and capabilities have to be completely redirected. It is not a simple matter to convince work groups that it is fundamentally <u>their</u> responsibility to monitor quality and productivity; it is equally difficult to convince manufacturing engineering personnel that their major function will be one of supporting factory teams, not dictating to them.

The need for training at all levels, therefore, is quite obvious. Changing organizational design is driving the need for training not only for transforming attitudes and habits but also to bring people to new levels of technical competence. As one H-P official said, "Training is a function of organizational design needs, and the primary element driving organizational design is technology. More and more, technology is forcing worker skills to be defined in terms of cognitive, not manual, abilities." That is, the need today is to design organizations not simply to produce a particular good or set of goods to some predetermined quality level, but rather to produce value added for customers. This entails having workers (and management) understand just what it is that contributes to that value added and to think in terms of what is needed to enhance that value further, and on a continuous basis. Assuming the training to inculcate such notions, the result is expected to be enormous improvements in manufacturing, much "flatter" organizations, and substantially greater job satisfaction and fulfillment.

Are such methods transferable to other U.S. corporations? Depending upon particular circumstances, the answer could go either way. The new organizational structure works only when workers and managers are willing to link their own destinies to the future welfare of the corporation, a linking that would seem to require an unusual degree of employee loyalty in many U.S. industrial settings. H-P executives believe that getting workers to learn human relations, technical and business skills, and to apply them in a dedicated way, requires reciprocal loyalty on the part of the company. Such metnods, therefore, certainly would not work effectively in settings where the immediate managerial response to business downturns is a reduction in workforce through layoffs.

ANNEX ONE

Companies Interviewed in Study

Apple Computer Company

Caterpillar, Incorporated

Diamond-Star Motors Corporation

General Electric: Aircraft Engine Division

Hewlett-Packard, Incorporated

Mead Corporation

Motorola, Incorporated

NCR Corporation

Procter and Gamble Company

Texas Instruments, Incorporated

United Technologies, Incorporated